

THE SENSATION OF DISCOMFORT.

By W. F. TYLER.

Under date of April 14, Mr. W. F. Tyler, Coast Inspector of the Imperial Maritime Customs Service, China, and in charge of the meteorological affairs of that service, writes from Shanghai as follows:

For the last few years I have given some attention to the question of a means for comparing climates, and have directed my little investigation toward ascertaining the relation between the subjective effects and the physical elements of climate. This eventually resolved itself into trying to find out what function "discomfort" is of temperature and humidity. I found that taking zero as a condition when, being suitably dressed, no personal discomfort is experienced, and 10 as the maximum discomfort known in Shanghai; then within the range of my observations the degree of discomfort is given by the expression

$$\frac{d - 1.2(d - w) - 66}{3}$$

where d and w are the readings of the dry and wet bulb, respectively. The range of my observations was from 0.2 to 0.6 of the maximum discomfort.

Now it seems to me that there is an important principle concerned in my method of dealing with this matter, namely, the graduation of sensation.

The estimation of degrees of sensation is, of course, only a means to an end. When the law connecting such degrees with the physical cause or causes has been ascertained, it will be possible to foretell what, under certain physical conditions, the degree of sensation will be.

In England I have experienced great difficulty in attracting any attention to my idea, the objection to it appearing to be that as it deals with a mental phenomenon it could not be viewed from the ordinary scientific standpoint.

But I have thought this nonappreciation might be at all events partly due to the want of experience of extreme climates. They have never had the opportunity of comparing, say, a temperature of 84° F. and a saturated atmosphere with a temperature of 100° F. and a relative humidity of 55 per cent. According to my scheme these two conditions cause the same degree of discomfort.

In your country, however, it is otherwise, and you have every condition of climate. The question then of comparison of these must be of the greatest interest. It is possible that this subject has already been dealt with in your country on somewhat the same lines indicated by myself, but if so it is curious that I have heard no reference to it in England.

In connection with the above letter, Mr. Tyler sends a copy of an article entitled "A scheme for the comparison of climates", reprinted from the *Journal of Balneology* for February, 1904. In this paper he maintains that there are two factors affecting human sensation incomparably more important than any others, namely, temperature and humidity, and that the same sensation of climate may be experienced by adjusting the temperature and humidity in accordance with the law expressed in the above equation. Other factors, such as soil, wind, aspect, rainfall, and altitude are appreciable, but temperature and humidity are the most important, and he expresses the joint effect of these two by the word "Hyther" (hygrometer and thermometer?). If this fundamental combination can once be determined, then the effects of pressure and sunshine may possibly also be expressed. It may, also, be possible to determine the extreme conditions of temperature and humidity in which human life can exist.

The want of an exact nomenclature for our sensations is felt as soon as we consider the immense range of climatic conditions.

In south Australia, with a shade temperature of 115° F., men wear starched collars and work in their offices without punkahs, while in Shanghai, with a shade temperature of 95° F., life may be rendered hardly worth living, even with cellular shirts and electric fans. How climate affects us is certainly not indicated on the thermometer or on any other existing instrument. It is indicated only by our bodily sensations, and our object is to find some way of describing these. * * * If any sensation, such as that caused by immersing the hand in water, is considered, and two definite limits are taken, such as water so cold that it makes one shiver, and so hot that it can just be borne, then the writer maintains that with practise the mind is capable of graduating this sensation into say ten equal parts, each corresponding with an equal difference of sensation. Undoubtedly all minds are not equally capable of

this. Out of twelve selected observers there were only three with fairly good indicative qualities. About the end of the summer of 1902, observations were made by twelve individuals in Shanghai over a period of one month. Each estimated daily, at noon, the sensation caused by the warm climate supposed to be the combined effect of heat and humidity, and each recorded the degree of hyther on a scale 0 to 10. Ten represents the very worst day that each observer remembers to have experienced in Shanghai, namely, hot, damp, and enervating; zero represents an ideal summer day, warm, bright, brisk, and bracing, when, being suitably dressed, one suffers no discomfort from temperature or humidity. The observers were of regular habits and accustomed to the same daily occupation at noon and without rush or worry. The corresponding meteorological observations were made at Zi-Ka-Wei Observatory. The individual observations are given in tabular form, as well as graphically. In each diagram the horizontal line represents degrees of dry-bulb temperature, and the vertical line represents the depression of the wet-bulb thermometer. The observer's estimated sensation on the scale of 0 to 10 is inscribed on the diagram¹ at the place shown by the intersection of the line of corresponding temperature and wet-bulb depression. Then lines are drawn connecting points of equal sensation. In the majority of cases the numbers or hythers do not seem to be arranged in simple curves or zones, but in general the higher and the lower numbers can be divided by a line that has about the same slope in all the diagrams. If, however, a mean is taken of all the numbers, the zones are fairly well defined. The preliminary study seems to show that temperature and humidity are of primary importance, but that some other factors have appreciable influence. As the record is given only for one month and the observers had no previous experience, it is not advisable to state conclusions too definitely. But one generalization seems to be allowable, namely, that the lines of equal comfort, or the zones of hythers, all run in approximately parallel directions, showing that the law governing the relation of humidity to temperature is similar in all cases.

As the reader is perhaps unacquainted with the rather extensive literature on this subject, we may perhaps refer him to the observations and writings of J. W. Osborne, of Washington, in the years 1872-1875, published principally in the *Proceedings of the American Association for the Advancement of Science*. Mr. Osborne also devised a scale of sensations expressed by both terms and numbers. He also constructed a very ingenious vessel of paper filled with warm water, whose temperature could be kept at any desired point, representing the balance between the heat lost by evaporation from the surface and that given to it by the air, and, therefore, to a certain extent corresponding to the temperature of the moist human skin. Mr. Osborne's observers took account of the wind as one of the most important climatic factors. For a long time the temperature of the wet-bulb thermometer was known as the "sensible temperature" or a temperature approximating that which might be supposed to represent the sensations that we experience, but this is evidently a very crude method of disposing of the subject, and has long since been given up. The idea of a curve of comfort, as explained by the Editor at pp. 362-3, *MONTHLY WEATHER REVIEW*, August, 1898, is quite analogous to the curve of discomfort as explained by Mr. Tyler. In both cases we seek a relation between some definite physiological condition and the temperature, moisture, wind, or other atmospheric condition. The preparation and study of these curves seem to offer the most practical method of recording and studying the relation of the weather to the condition of the nervous system.

THE PRESSURE OF SUNLIGHT AND SOME OF ITS BEARINGS ON ASTRONOMY AND METEOROLOGY.

By S. A. MITCHELL, Columbia University, New York, dated May 19, 1904.

How science changes its point of view and adopts new hypotheses as occasion demands is splendidly illustrated by the story of comets and their tails. Since the first explanations of the strange behavior of these tails given nearly three hundred years ago, even before the foundation of the law of gravitation, there have been plenty of theories propounded, and earlier ideas have been gradually discarded on becoming untenable through improved knowledge of the laws of matter.

¹The diagram is not reproduced.